

Japanese Progress in LCA

Recent Progress of LCA Activities in Japan

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Introduction

LCA has received great attention in Japan along with its international standardization. Many Japanese industries recognize the importance to advertise their products as environmentally friendly products, and some companies have conducted LCA case studies to show customers the data of their products, which are published in their environmental reports as well as the proceedings of the conferences and academic journals.

LCA experts in national institutes and universities also have developed methodologies for life cycle inventory analysis and impact assessment. These are reported at some conferences and symposiums related to LCA held in Japan during 1999-2000.

In this paper, recent activities concerning Life Cycle Assessment in Japan were reviewed mainly introducing symposiums and conferences after the '3rd International Conference on EcoBalance' held on November 1998 [1].

1 Eco-Products and Eco-Design

1.1 The exhibition 'Eco-Products1999', Dec. 7-10, 1999, Tokyo [2]

Recently, 'Eco-Products' has been in fashion in Japan. For example, the exhibition 'EcoProducts1999', which was held on December 7-10, 1999 at Tokyo International Exhibition Hall supported by the Ministry for International Trade and Industry, got approximately 30,000 visitors during three days. 274 companies and 14 NGOs displayed their activities (Table 1).

Table 1: Fields of industries on Eco-Products 1999

Field	No.	Field	No.
Materials	57	Other Machines/Parts	13
Daily goods	44	Electric Appliances	12
Housing	26	Servers	9
Clothing	26	Foods	7
Building/Construction	24	Office Machines	4
Stationery	24	Hobby/Amusement	4
Energy/Power Generation	18	Eco-function products	36
Electronics	17	Eco-information	23
Automobile/Machine	13		

Many companies recognize the importance of producing 'Eco-products'. The criterion of 'Eco-products', however, has not yet been clear. There were few products that were evaluated using LCA. 'Eco-Products2000' is now planned on December 14-16, 2000 at the same place in Tokyo.

1.2 'EcoDesign1999 – 1st International Symposium on Environmentally Conscious Design and Inverse Manufacturing', Feb. 1-3, 1999, Tokyo, Japan [3]

This symposium was supported by the Inverse Manufacturing Forum Japan and JEMAI in cooperation with the IEEE Computer Society, the Technical Committees on Electronics and the Environment. Approximately 120 participants joined from 21 foreign countries such as the USA, UK, European countries, China, Korea, Taiwan and Brazil. The total participants were approximately 500 during 3 days.

Inverse Manufacturing was one of the key words of this symposium, which was the concept to reduce the consumption of materials by disassembling and material recycling. The Inverse Manufacturing Forum [4], Japan was established on December 1996 and was participated by 56 companies mainly from electronics equipment and electric appliance industries. The Environmental Information System [5] to exchange information on the assembling and disassembling of electric appliances has been open to the public by internet since 1998 as a result of the Forum, which was presented by Miyamoto of NEC Corp., and by Ohashi of Hitachi Ltd. at this symposium.

The presentations of the symposium were mainly focused on more practical ways to promote reuse and recycling of the assembly products, rather than the environmental aspects. As a closing remark to the symposium, the 'Manifesto of Ecodesign', drafted by Professor Ryoich Yamamoto of Tokyo University, was adopted, and more than 50 people signed on it.

Also taking this opportunity, the union of ecodesigners [3] was established which was a loose relationship of the academic societies concerning 'Ecodesign'. The aim of this union, for the present, is to organize the conferences.

The Union held the 'EcoDesign1999 – Japan Symposium' on December 10-11, 1999, Tokyo [3] at the same time and place as 'Eco-Products1999'. The number of participants was about 300. This symposium covered broad topics related to Eco-Design of industrial products. 17 sessions were organized for Eco-Design, Environmental Education, Lead-Free Technology, Recycling & Reuse Technology, Mainte-

nance Engineering, Energy-Saving Technology, Green Purchasing, Environmental Management System, Eco-Material, etc. No LCA session was organized. However, some LCA case studies were presented.

Kachi introduced their activities of an LCA case study for copier machines, in which the effects of reusing parts on environmental impacts were being investigated. Kimura presented a weighting method, 'Eco-Load Standardization Scheme', and its application to vending machines. The Union is now planning 'EcoDesign2000' on December 2000, in Tokyo, Japan.

1.3 'The Role of LCA in ISO-14000 Series and Practical LCA in Company', Feb. 28, 2000, Tokyo [6]

One of the other applications of LCA is DfE (Design for Environment), which is now discussed in ISO/TC207/WG3. The aim of this symposium was to discuss the relationship of the ISO-14000 series, for example, Environmental Management System, Eco-label, LCA and DfE. More than 120 participants discussed the definition of DfE at this symposium. Although Steven B. Young of Five Winds International presented the DfE as a system of environmental management within company, many participants were still considering how LCA worked in DfE and the relationship between LCA, the 'check list' of Eco-Design and DfE.

As described above, the words of Eco-products and Eco-design have not been clearly defined in Japan. Moreover, DfE has been thought to be a part of design for disassembling because of the similarity of the words. The concept of LCA has taken a firm hold on Japanese companies, at least on the big enterprises. The practices and applications of LCA, however, are now on the step of distribution.

2 LCA and Type 3 Label on Environmental Reports

Interest in environmental aspects of Japanese industries is also reflected in an increase of the number of companies that issued their environmental reports. We obtained more than 70 companies' environmental reports during last year. They are mostly users of 'NIRE-LCA, Ver.2' developed by the National Institute for Resources and Environment, which has been distributed, free of charge, to both industry and universities with approximately 250 being received by the former and 40 by the latter. It might be thought that these companies lead LCA activities in Japan.

Some of the environmental reports illustrated their LCA activities, which were shown in Table 2 (see Appendix). Automobile industries, electric appliance industries, business machine industries, printing/packaging industries and construction industries have adopted LCA to assess environmental aspects of their products. Although basic materials industries also issued environmental reports, LCA does not appear in their reports.

The scope of their LCA case studies was limited to energy consumption and CO₂ emissions in most cases. One reason is the difficulty in collecting data due to lack of a publicly available database. Another reason seems that the possibilities to reduce CO₂ emissions and/or energy consumption

may lead to reduction in the direct cost of the products. Moreover, the Japanese Government strongly recommends the reduction of CO₂ emission to industries because of the Kyoto Protocol of COP3 in 1997.

Processes of mining resources were excluded in the system boundary in most cases. The reason is also the difficulties in collecting data, because Japan imports a lot of mineral resources from foreign countries. International cooperation to develop a database including mining processes is necessary in order to conduct LCA in Japan. It is described later in this paper.

The results of LCA for industrial products are expected to be applied to Type 3 label. As we can see in Table 2, some companies have already published them as can be seen on their web sites. The Japan Environmental Management Association for Industry(JEMAI) is now preparing the guideline of Type 3 label in cooperation with environmentally advanced companies. These activities, however, seem to be more progressive underground on confidential bases.

3 LCA on Eco-materials and Waste Management

As mentioned in Chapter 1 on Eco-products and Eco-design, LCA methodologies related to disassembling and parts/material recycling systems are discussed widely in Japan. From this viewpoint, the following two conferences must be referred to in this chapter.

3.1 The Fourth International Conference on Ecomaterials, Nov. 9-12, 1999, Gifu, Japan [7]

This international conference was held every second year in Japan. The total participants were approximately 300 this time. A session for LCA was organized in this conference. In addition, there were sessions for Eco-Product and Metal Recycling in which researches related to LCA were presented.

The number of participants in the LCA session was about 30. Some of them were from Germany, Great Britain and Korea. Dove and Sugita presented eco-profiles of metals and discussed allocation methods for primary metal production processes. Sakai presented uncertainty analysis in LCA using a perturbation method.

In the Eco-Product session, some LCA case studies were presented. Betz presented a comparative study of tires; carbon black tire and silica/silane tire. Kosan presented an LCA case study of household electric product waste treatment. Nakamura presented the environmental load for bathroom and sanitary products. In addition, Nie introduced the current research status of Chinese Ecomaterials.

In the Metal Recycling session, Narita presented life cycle inventory analysis of steel products by reduction agent injection into a blast furnace.

3.2 10th Annual Conference of The Japan Society of Waste Management Experts, Dec. 26-28, 1999, Omiya, Japan [8]

This conference was one of the large conferences focusing on waste management. There were approximately 1500 partici-

pants this time. LCA sessions were organized in this conference. There were 100 participants and 21 presentations in LCA sessions, most of which were related to waste management and recycling.

LCA case studies for various product systems were presented. They included papers, packaging materials for milk, televisions, bumpers for automobiles, sewage disposal processes and waste management processes. In most of the case studies for products, the effect of recycling products after their use on environmental impacts was investigated.

LCA methodologies were also discussed. Inaba presented methodologies to assess land occupation with solid waste landfill and to integrate environmental impact assessment using the concept of a carrying capacity. Terazono applied comparative risk assessment to life cycle impact assessment for packaging materials and presented the results. Nakamura and Hashimoto presented methodologies to calculate environmental impacts of wastes with an Economic Input-Output table.

4 Development of LCA Software and LCI Database

4.1 The symposium 'State-of-the-Art of LCA Activities in Japanese Industries', Jan. 24, 2000, Tsukuba, Japan [9]

As a tool of practice, LCA softwares have been developed in Japan. For example, 'NIRE-LCA, Ver.3', a successor of 'NIRE-LCA, Ver.2' mentioned above, through which the ISO diagram is navigated, was almost completed in development by the National Institute for Resources and Environment. 'Easy-LCA' by Toshiba cooperation and 'LCA-Support' by NEC-Kansai are in commercial use. These were presented at this symposium.

Also at 'EcoDesign 99 Japan Symposium' mentioned above, some supportive tools for LCA were introduced. Miyamoto of NEC Corp. presented 'FusionNET LCA', a network system for LCA which would reduce the time for LCA practitioners to conduct an LCA. Akai presented the development of 'ISO-LCA Navigation Software' which would enable one to conduct an LCA in accordance with ISO standards.

LCI data for Japanese industries processed using industrial, statistical data and the analysis of industrial processes have been provided along with these software activities. LCI data of the average of industrial activities prepared by the industrial associations will be published in the near future as a result of the LCA project by JEMAI and MITI. These data must be useful for the publication of the Type 3 label and other application of LCA practice.

5 International Cooperation

5.1 The UNEP/APEC/AIST/NEDO Joint Symposium 'LCA for Asia Pacific Region', Nov. 24-25, 1998, Tsukuba [10]

It took place at Tsukuba, Japan, to exchange information of LCA activities of each country in the Asian-Pacific Region. Because the Asian-Pacific region has some shared geographic, economic, and environmental resources, it is important that cooperation between countries in Asia is established to further LCA development and use. There is already a firm base

of LCA in the Asian-Pacific region shown in the country reports at this symposium [11]. However, there is far more work to be undertaken than has already been done. The group report of participants [11] expressed that an Asian LCA forum should be established to help this work, and should guide a range of projects and activities to promote, develop and improve LCA in the Asian-Pacific Region.

5.1 LCA for Asian Countries, January 24, 2000, Tokyo [12]

In this symposium, Matsuno reported LCA activities of Korea, China, Malaysia and India, which he visited last year. And then, Uematsu gave a presentation about the importance and difficulty of international cooperation with his experience of the APEC/GEMEED project, which has held workshops twice in the last two years.

In general, as mining and mineral processing are basic to various industries, the promoter of LCA in each industry has requested the introduction of LCA to the mineral industry. However, as LCA involves the comparison of environmental impact assessments for materials, it is anxiously thought that LCA has the potential to generate a trade barriers if the methodology and input data for different products and materials lead to misleading results. Thus, in order to avoid diverse approaches being developed for the application of LCA to the mineral industry by different countries and companies, there needs to be a common approach to LCA applications. It is one of the reasons that LCA must be conducted under the international collaboration.

This year, the APEC/AIST/NEDO Symposium, 'LCA for APEC Member Economies Collaboration on LCA for Basic Materials and Energy Production', will be held in cooperation with the 4th International Conference on Eco-Balance, Tsukuba, Japan, October 31 to November 2, 2000. An introduction of the LCA activities in the Asian-Pacific Region has already been spread. In this symposium, we have to find out the exact way of how to collaborate for conducting an LCA and developing an LCI database.

6 Need of a New Concept of LCA

6.1 The symposium 'Development of New Methodologies for LCA-Social LCA and Dynamic LCA', March 3, 1999, Tsukuba, Japan [10]

On the other hand, many Japanese seem to recognize that it is necessary to append some new aspects on ISO-LCA or to develop a new methodology beyond ISO-LCA, in order to describe the performance of companies, and the relationship between companies and the society. Moreover, it is thought that ISO-LCA is insufficient for illustrating the future scenario of the long-time technologies to mitigate environmental loads. At this symposium, the necessity of new LCA methodologies was discussed by more than 140 participants. It must make up for two limits of ISO-LCA that are the lack of evaluation of social activity and time dependency. The author named a methodology for focusing on social activities including the evaluation of company and industry as 'Social LCA', and 'Dynamic LCA' was named

for new methodologies focusing on time dependency. Although there is a discussion that the names of 'Social/Dynamic-LCA' present other concepts in Europe, and that new words to present these somewhat new concepts were required, many people in Japan have also expected new concepts beyond ISO-LCA to present their activities. LCA experts and practitioners must discuss this topic further.

7 Conclusions

In this paper, LCA activities were reviewed mainly focusing on symposiums and conferences. There are more other activities that were not described here. One of them is the national LCA project [12] promoted by JEMAI, which was introduced in this journal [13]. In this project, the methodology of life cycle impact assessment for Japan has been developed, the progress of which was also introduced in this journal [14].

As mentioned in this paper, the '4th International Conference on Eco-Balance' [15] will be held at Tsukuba, Japan, on October 31 to November 2, 2000. This international conference is held every second year in Tsukuba, Japan. The sub-title this time is 'Methodologies for Decision Making in a Sustainable 21st Century', in which new concepts based on LCA will be discussed to realize the sustainability of the world. Many LCA case studies will also be presented. The APEC/AIST Symposium, 'LCA for APEC Member Economies – Collaboration on LCA for basic materials and energy production', where case studies from Asian countries will be presented and the future collaboration will be discussed, will be held at the same time and the same place.

'Ecodesign2000' will be held in December 2000, at Tokyo at the same time as 'EcoProducts2000', as mentioned above. These symposiums and the exhibition may be more practically ori-

ented and offer a little bit more focusing on recycling and reuse than the '4th International Conference on Eco-Balance'.

Many people and companies in Japan pay attention to LCA and LCA-related methodologies. In the beginning of next century, Japan must be one of the most active countries of the environmental aspects in the world. I would like to submit Japanese information continuously to this Journal.

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Appendix

Table 2: LCA activities on companies' environmental report in Japan

Industry	Company	Reported year	LCA case studies reported in the report	Other LCA related activities
Automobile	TOYOTA	1999	Comparative study of automobiles: COROLLA (normal car) and PRIUS (hybrid car) Scope: CO ₂ emissions and energy consumption System boundary: From transport of resources to disposal	<ul style="list-style-type: none"> • Study of LCA methodology for automobiles: application of LCA to environmental assessment and product design • Investigation of use phase of automobile • Development of a model to evaluate the effect of recycling materials
	NISSAN	1999		LCA methodology is now being investigated. There seem problems in collecting data for unit product
	HONDA	1999		<ul style="list-style-type: none"> • LCA study committee has been established since 1997 • A practically applicable LCA methodology is being developed. 'HONDA LCA' – Investigation of scope, data collection, and setting of management category • LCA is to apply for energy conservation • LCA is investigated as one of the environmental management tools and technology assessment tools

Table 2: LCA activities on companies' environmental report in Japan (cont'd)

Industry	Company	Reported year	LCA case studies reported in the report	Other LCA related activities
Business Machine	RICOH	1999	<ul style="list-style-type: none"> Material recycling of resins for external copier cabinets Buffers Copier paper Scopes of these case studies are CO ₂ emissions	<ul style="list-style-type: none"> Introduction of Eco Balance – a compilation of environmental impact input and output data and is a means of quantitatively measuring, assessing, and reporting the environmental impact generated by a company A Type 3 Environmental Label is also being prepared
	CANON	1999	<ul style="list-style-type: none"> Copier machine Printers 	Conducting "Product Assessment" based on LCA methodology
	KONICA	1998		LCA study committee was established in 1997. LCA is being introduced.
Electric appliance	FUJITSU	1999	<ul style="list-style-type: none"> Liquid crystal display (LCD) Desktop personal computer Laptop personal computer 4 products in 1998 LCA has been applied to 6 products in total so far. Scope: CO ₂ emissions	Use of LCA results for developing new products
	NEC	1999	<ul style="list-style-type: none"> Fax machines Printers Pagers LCDs Switching systems (11 product categories in 1998) LCA evaluation completion by each product group is 41% of communications system equipment, 33% of computers and 60% of electronic devices. Scope: mainly CO ₂ emissions	<ul style="list-style-type: none"> LCA methodology has been developed since 1997 'LCA Support Center' was established in 1998, the purpose of which is to support internal evaluations and provide information on LCA through seminars and the nurturing LCA experts NEC's LCA method has been patented in the United States and is pending in Japan
	SONY	1999	Television (28 inch wide TV) Scope: CO ₂ emissions Weak-point analysis of the product during the life cycle	
	NATIONAL/PANASONIC	1999	LCA case studies have been conducted to assess environmental impact of products since 1996. LCA was applied to plan and design the new type of air conditioner in 1998	
	NATIONAL	1999	Comparative study of 'Hf inverter' fluorescent lamp and conventional fluorescent lamp Scope: Global warming, acidification, air pollution, water pollution, energy consumption, resource (iron, copper, oil) consumption, toxicity	<ul style="list-style-type: none"> Fundamental guide of LCA was developed in 1998
	DAIKIN	1999	Comparative study of conventional type and new type air-conditioners Scope: energy consumption, global warming, ozone layer depletion, acidification, air pollution, heavy metal emissions, water pollution (eutrophication), resource consumption	<ul style="list-style-type: none"> LCA has been introduced since 1995. LCA was applied in the development of new products to improve the environmental impact LCA software for air conditioners under development. It contains the data of refrigerants and electronic parts
Machinery	HITACHI	1999	Washing machines	LCA is integrated with other tools, i.e. 'chemical substance check sheet' and 'guidance for eco-material selection' for development of environmentally conscious products
	Kubota	1999	Small type gasoline engines Scope: energy consumption System boundary: From production of materials to usage	
	SHIMADZU	1999		LCA is being applied to products
	EBARA	1999	<ul style="list-style-type: none"> Barreled motor pump Hzfree Pressurized two-stage gasification process Ultra fine particulate oil mist atomizer Scope: energy consumption	

Table 2: LCA activities on companies' environmental report in Japan (cont'd)

Industry	Company	Reported year	LCA case studies reported in the report	Other LCA related activities
	EBARA	1999	<ul style="list-style-type: none"> Barreled motor pump Hzfree Pressurized two-stage gasification process Ultra fine particulate oil mist atomizer Scope: energy consumption	
Ceramics	TOTO	1999	Toilets Scope: CO ₂ emissions System boundary: From production of materials to usage	
	INAX	1999		LCA is used in design of the products with other tools
Print & Package	DNP	1998		LCA methodology was developed for package products in November 1997
Construction	KAJIMA	1998	LCA has been applied to products since 1996. Scope: CO ₂ emissions	<ul style="list-style-type: none"> Solid wastes from building during the life cycle are investigated by 'Life Cycle Waste (LCW)' program. Selection of materials, constructing methods and disposal methods was investigated for improvement of recycling ratio, reduction of solid wastes and environmental impacts in waste treatment processes LCA (LCCO₂) is integrated with LCW systems
Material	TOYOBO	1999		<ul style="list-style-type: none"> Methodology based on LCA to assess products was developed: "Eco-product check sheet" Five stages are considered. (Resource production, material production, transport, usage, disposal) Five impact categories are considered. (Resources consumption, energy and water consumption, solid wastes, air pollutants, water and solid pollutants)

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Thomas McKone	Human Toxicity Potential
Gregory Norris	Advances in Normalization & Weighting in North American LCA
Gregory Norris	Risk-Based Integration of Economics and Life Cycle Environment: Two Methods
Karen Shapiro	Incorporating Costs in LCA
Duane Tolle	Comparison of Two Equivalency Factor Approaches with Simplified Risk Assessment for LCIA of Toxicity Impact Potential
David Pennington	Screening and Ranking in the Context of Implicit Toxicological Concern: A Comparison of Methodologies and Requirements
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